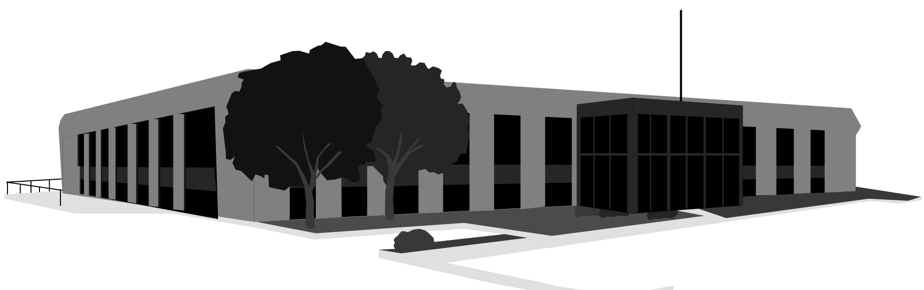
# INDOOR AIR QUALITY ASSESSMENT

**Forest Park Middle School**
**46 Oakland Street**
**Springfield, Massachusetts**




Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment

July, 2000

## Background/Introduction

At the request of a parent, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at the Forest Park Middle School, 46 Oakland Street, Springfield, Massachusetts. Concerns about ongoing painting odors prompted this request.

On May 11, 2000, a visit was made to this school by Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA, to conduct an indoor air quality assessment. Mr. Feeney was accompanied by Steven Stathis, Director, Division of Environmental Health, Springfield, Department of Health and Human Services.

The school is a two-story brick structure that was built in two stages. The original school building was constructed in 1897 (see Picture 1). A wing was added to the building in 1919 (see Picture 2). Windows are openable throughout the building. Energy efficient windows were installed in the north wall of the building (see Picture 3).

School officials plan for this building to be replaced within the next year and a half. The recommendations in this report outline different methods that can be used to improve indoor air quality for the comfort of building occupants until the renovation and/or demolition and replacement occurs.

## Methods

Air tests for carbon dioxide were taken with the Telaire, Carbon Dioxide Monitor and tests for temperature and relative humidity were taken with the Mannix, TH Pen PTH8708 Thermo-Hygrometer.

## Results

The school has a student population of 900 and a staff of approximately 70. The tests were taken during normal operations at the school. Test results appear in Tables 1-6.

## Discussion

### Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in thirty-seven of fifty-four areas surveyed, indicating an overall ventilation problem in the school. It is also noted that a number of areas with carbon dioxide levels below 800 ppm either had open windows and/or were sparsely populated during the assessment, both of which can greatly contribute to reduced carbon dioxide levels. Rooms 101, 121, 205, 206, 207, 209, 210, 211 and the speech room, were all over 800 ppm carbon dioxide without occupancy, indicating little or no air movement.

Each wing is outfitted with different types of ventilation systems. The 1919 section of the building is provided with a natural/gravity ventilation system, to be used in combination with openable windows. Ventilation is provided by a series of louvered vents. Each classroom has an approximately 3' x 3' grated air vent in the center of an interior wall near the ceiling (see Picture 4), which is connected by airshafts to two separate vaults in the basement. Fresh air movement is provided by the stack effect. The heating elements (see Picture 5) located in the basement heating vault warm the air, which rises up the fresh air ventilation ducts. As the heated air rises, negative pressure is created, which draws outdoor air through windows into the basement heating vault (see

Picture 6). This type of system was originally designed to draw air through an openable window system on the exterior wall of the building. This window would be adjusted to increase or decrease fresh air intake.

Exhaust ventilation is drawn from the classroom into an ungrated hole located at floor level (see Picture 4). A flue located inside the duct controls airflow. Above the flue is a heating element, that creates ventilation in the same method as the fresh air supply system.

During summer months, ventilation within the 1919 section is controlled by the use of openable windows in classrooms. This section was configured in a manner to use cross-ventilation to provide comfort for building occupants. The building is equipped with windows on opposing exterior walls. In addition, the building has hinged windows located above the hallway doors. This hinged window (called a transom) (see Picture 7) enables the classroom occupant to close the hallway door while maintaining a pathway for airflow. This design allows for airflow to enter an open window, pass through a classroom, pass through the open transom, enter the hallway, pass through the opposing open classroom transom, into the opposing classroom and exit the building on the leeward side (opposite the windward side) (see Figure 1). With all windows and transoms open, airflow can be maintained in a building regardless of the direction of the wind. This system fails if the windows or transoms are closed (see Figure 2). Each classroom would have a long pole with a hook that was used to open the hoop latch that locks the transom closed. Most transoms in the 1919 building were closed during the assessment, which can inhibit airflow in the summer.

The 1897 section has fresh air supplied by a unit ventilator (univent) system (see Picture 8). Within each univent is a fan (see Picture 9). Opposite this fan is a set of moveable louvers through which fresh air enters the univent (see Picture 10). Each of these louver systems appears to be set by hand to regulate fresh air intake into the univent. In order for univents to function as designed, univent fresh air diffusers and return vents must be unblocked and remain free of obstructions. Importantly, these units must be activated and allowed to operate.

Exhaust ventilation in the 1897 section is provided by a natural/gravity feed system. Exhaust ventilation is drawn from the classroom into an ungrated hole located at floor level. A heating element within the shaft creates ventilation in the same method as the 1919 section.

To provide ventilation during warm weather, the 1897 wing is also equipped with openable windows (see Picture 11). Since the exhaust ventilation system is non-mechanical, no airflow is created by this system once the boiler system is deactivated. Therefore, to increase airflow, cross ventilation using windows would be used to create airflow in this section of the building. Doors in the 1897 section are not equipped with transoms. In order to create cross ventilation, classroom hallway doors and windows need to be opened. Classroom doors were closed in a number of areas at the time of the inspection.

A number of classrooms located in the building, originally designed as storage/janitorial/entrances, appear to have been converted into classrooms, break rooms or other school related space. Some of these spaces do not have mechanical fresh air supply systems.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last servicing and balancing was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings ranged from 71$^{o}$ F to 77$^{o}$ F, which was within the BEHA recommended comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70$^{o}$ F to 78$^{o}$ F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Temperature control is difficult in an old building without a functioning ventilation system.

The relative humidity was measured in a range of 31 to 46 percent. Many areas sampled were below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. However, classrooms 17, 18, 18A, 19, 101, 104, 105, 108, 109, 115,120, 121, 122, 206, 222, 223, 224 and cafeteria had relative humidity measurements 1-9 percent higher than the relative humidity measured outdoors (37%) on the day of the assessment. The increase of relative humidity in these rooms can be attributed to lack of airflow. Without airflow created by cross ventilation, water vapor from classroom occupants can build up, as demonstrated by the relative humidity measurements. Please note that each of these classrooms had carbon dioxide levels in excess of 800 ppm, which also indicates poor air exchange. The sensation of dryness and irritation is common in a low relative humidity environment. Humidity is more difficult to control during the winter heating season.

Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

### Microbial/Moisture Concerns

Classroom 104 had water-damaged wall plaster which can indicate leaks from plumbing in the home economics room on the second floor. Water-damaged wall plaster can provide a medium for mold and mildew growth especially if wetted repeatedly. These materials should be repaired/replaced after a water leak is discovered and repaired.

Several classrooms also had a number of plants. Plant soil and drip pans can serve as source of mold growth. A number of these plants did not have drip pans or were in outdoor type planters with no drainage. The lack of drip pans and drainage can lead to water pooling and mold growth on windowsills when used indoors. Wooden sills can be potentially colonized by mold growth and serve as a source of mold odor. Plants should also be located away from univents to prevent the aerosolization of dirt, pollen or mold.

Classroom 209 had spaces around tile near the sink countertop. Improper drainage or overflow could lead to water penetration of countertop wood and potential damage to the cabinet interior. Water-damaged wood and standing water may also be a potential source of mold growth.

Shrubbery in direct contact with the exterior wall brick was noted in several areas around the building (see Picture 12). Shrubbery can serve as a possible source of water impingement on the exterior curtain wall due to the location of plants and tree branches growing directly against the building. Plants retain water and in some cases can work its way into mortar and brickwork causing cracks and fissures, which may subsequently lead to water penetration and possible mold growth.

### Other Concerns

A number of other conditions that can potentially affect indoor air quality were also observed. Recommendations concerning methods of containment for renovations were previously made to Carol Fazio, principal of the Forest Park Middle School. (MDPH, 2000).

Several classrooms contained excessive chalk dust. Chalk dust can become easily aerosolized and serve as eye and respiratory irritants. The teacher's workroom contained five photocopiers. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). No mechanical exhaust ventilation is provided in this area. Without mechanical exhaust ventilation, excess heat, odors and pollutants produced by office equipment can build up and lead to indoor air quality complaints.

## Conclusions/Recommendations

In view of the findings at the time of our inspection, the following recommendations are made:

1. Implement corrective actions recommended in letter concerning painting as soon as possible (see Appendix A).

2. Survey 1897 classrooms for univent function to ascertain if an adequate air supply exists for each room and make univent repairs as needed. Hand set fresh air louvers to increase the percentage of fresh air intake if necessary. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
3. Use transoms in the 1919 section to enhance airflow during warm weather. Be sure to close transoms at the end of the school day. To aid in the draw of fresh outdoor air in warm weather, use portable fans directing air out windows on the leeward side (opposite the windward side) of the building. Fans positioned in this manner will serve to increase the draw of outdoor air across a school floor without interfering with the natural internal airflow pattern of the building. To aid cross ventilation, open hallway doors.
4. Operating the univent system during hot weather will supplement the use of open windows. If sections of the ventilation system do not operate, the placement of fans to exhaust air from the leeward side of a building with hallway doors open may be employed. With this type of ventilation system, univents should be operating during school hours with the fresh air damper open 100% to enhance airflow into classrooms. This converts each univent into a large fan system.
5. To maximize air exchange, the BEHA recommends that univents operate continuously during periods of school occupancy independent of classroom thermostat control.
6. Repair the pulley chain/louver door systems in vents to provide ventilation as designed. Repair the hinged-pulley system windows to provide fresh air to 1919

classrooms. Consider restoration of the building's original floor vent system to improve air movement, which would consist of removal of plugs from cool air vents on first floor. Regulate airflow in these classrooms with the use of the gravity/natural ventilation system and windows to control for comfort.

7. Reseal science classroom sinks.
8. To introduce fresh air to 1919 classrooms in the winter, open the windows in the basement heating vault to provide fresh air to classrooms.
9. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
10. Move plants away from univents in classrooms. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
11. Reduce/trim or remove plants that are growing against the exterior brick curtain wall.
12. Repair/replace water damaged plaster, examine surrounding non-porous areas for mold growth and disinfect with an appropriate antimicrobial if necessary.

13. Consider installing local exhaust ventilation in teacher's room to operate during photocopying activities to remove excess heat and odors.
14. Clean chalkboards and trays regularly to prevent the build-up of excessive chalk dust.

## References

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

MDPH. 2000. Letter to Carol Fazio, Principal, Forest park Middle School, from Suzanne Condon, Director, BEHA Concerning Painting at Forest park Middle School, Springfield, MA, Dated June 2, 2000. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

Figure 1 Cross Ventilation in a Building Using Open Windows and Transoms

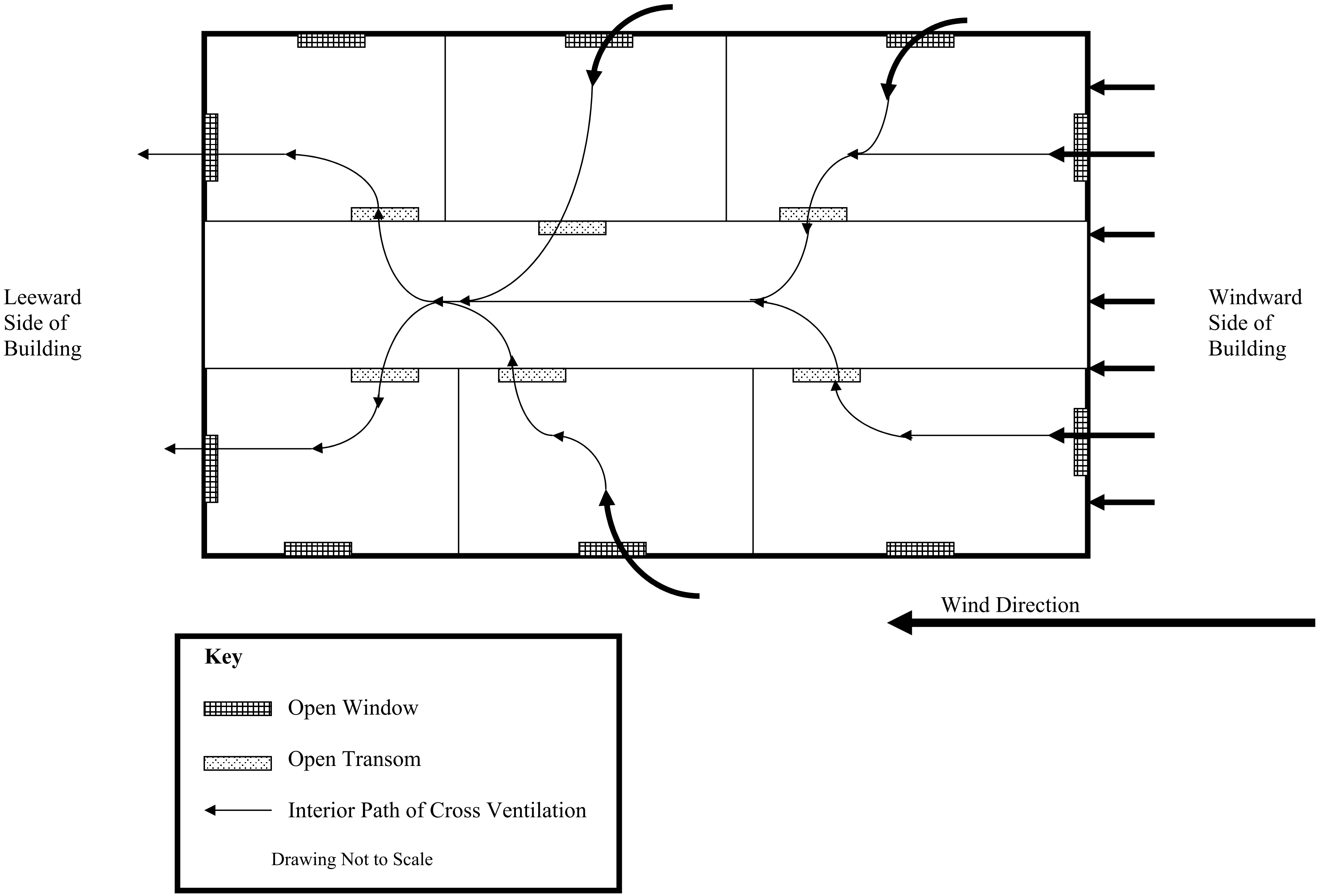
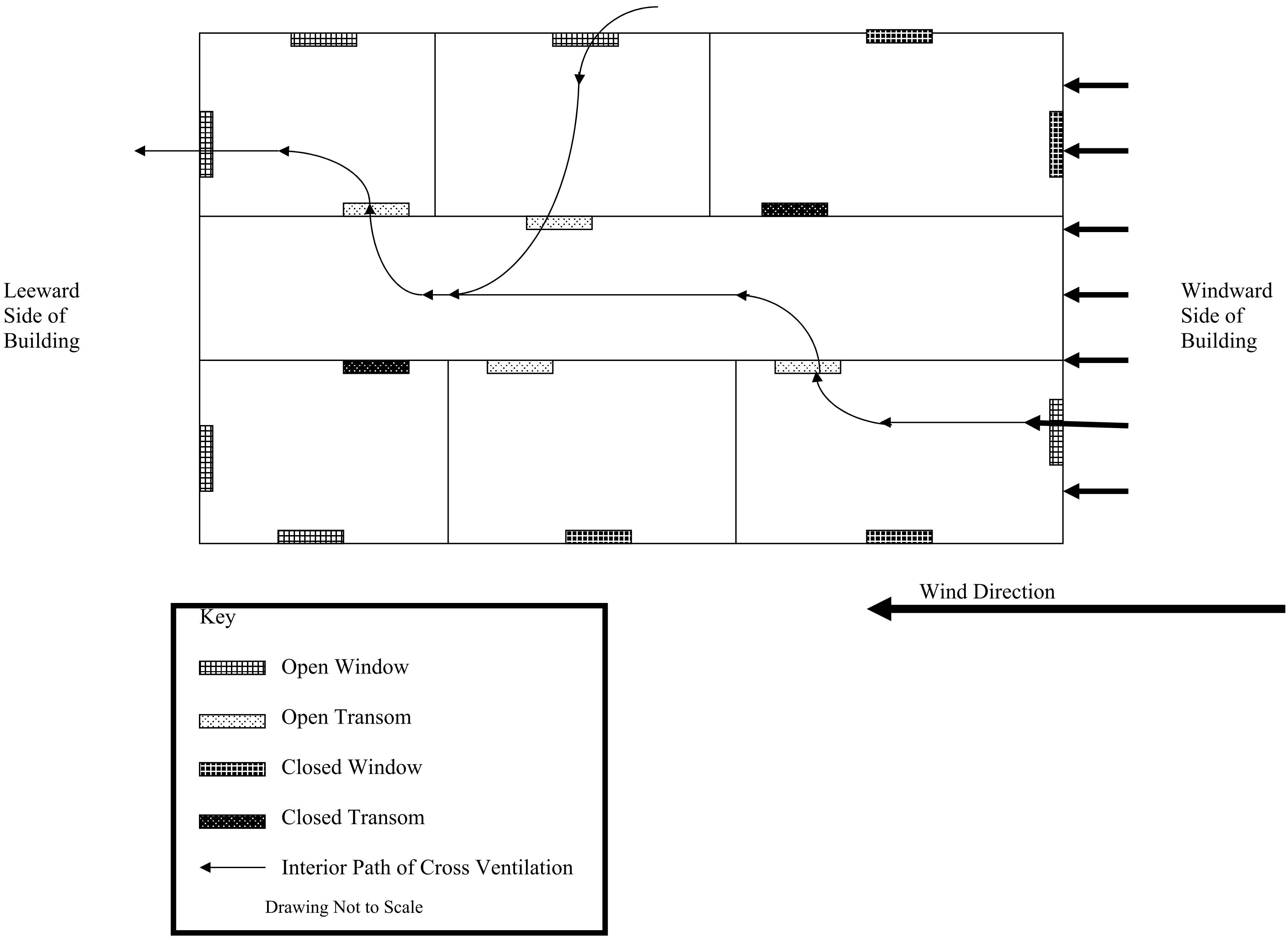


**Figure 2** **Inhibition of Cross Ventilation in a Building with Several Windows and Transoms Closed**



**Picture 1**

**The 1897 Building**

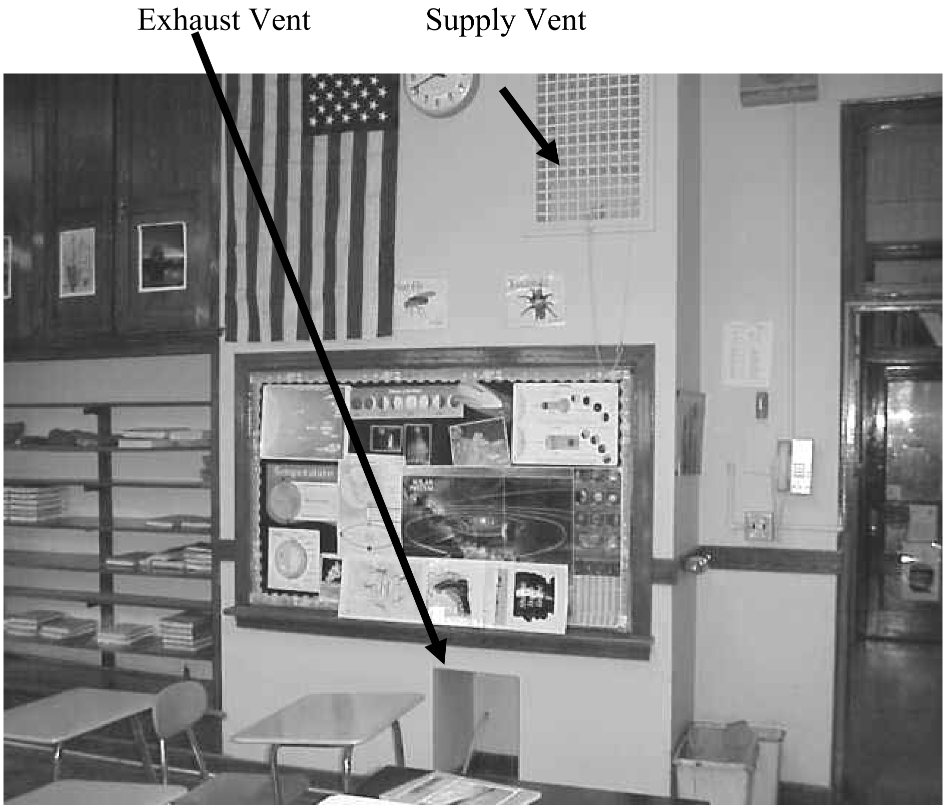
**Picture 2**

**The 1919 Wing**

**Picture 3**

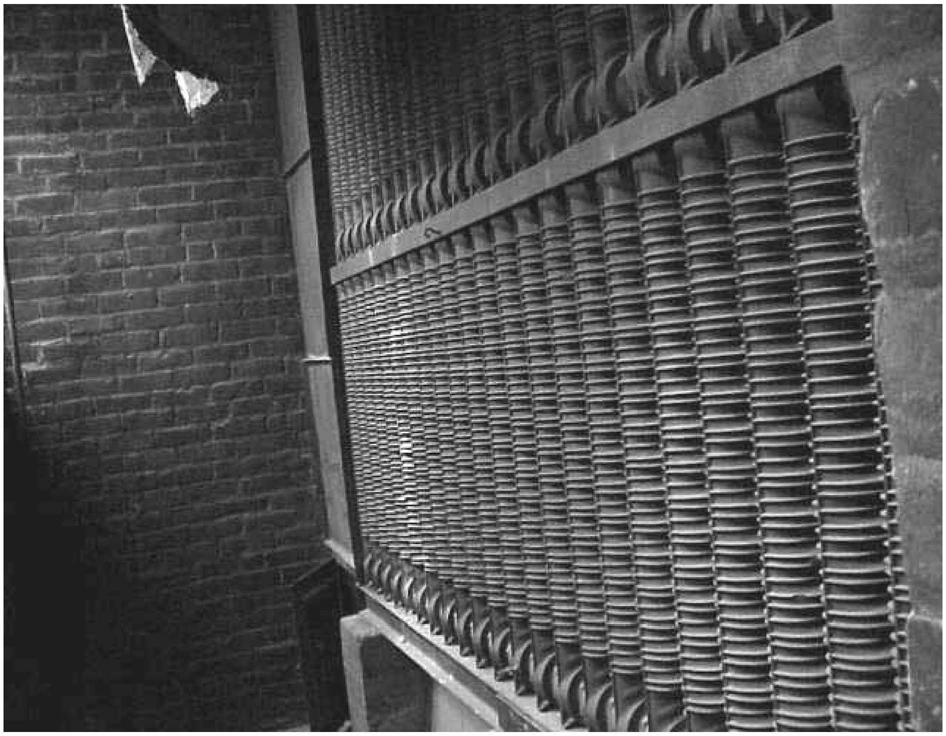
**Energy Efficient Windows of the 1897 Wing**

**Picture 4**



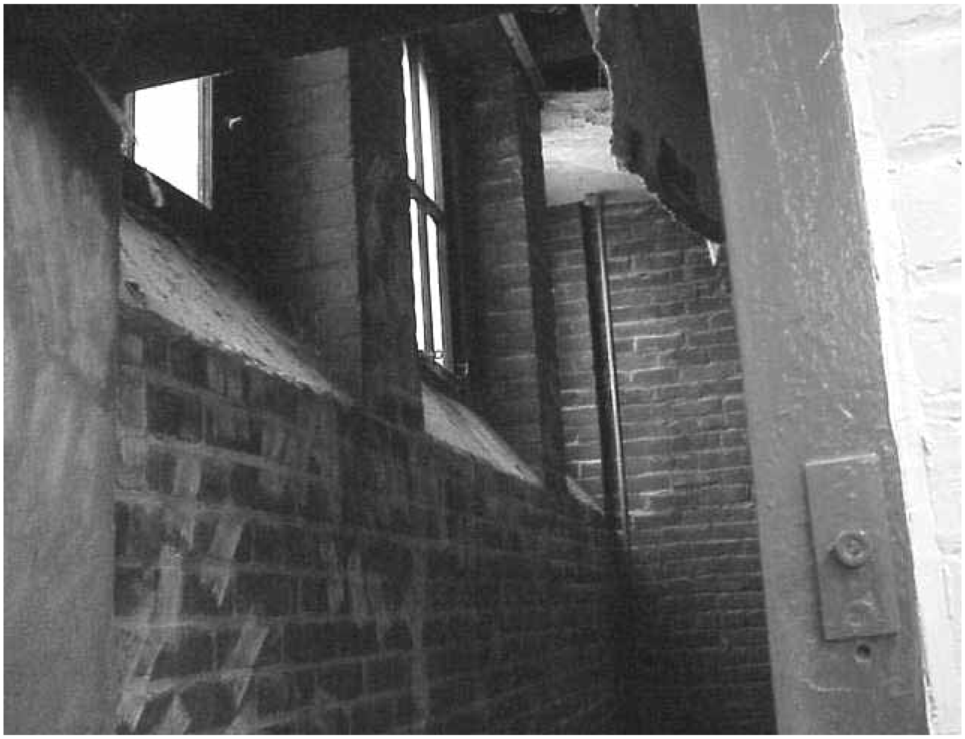

**Configuration of the Gravity Ventilation System in the 1919 Wing**

**Picture 5**



**Heating Elements in the Basement Heating Vault**

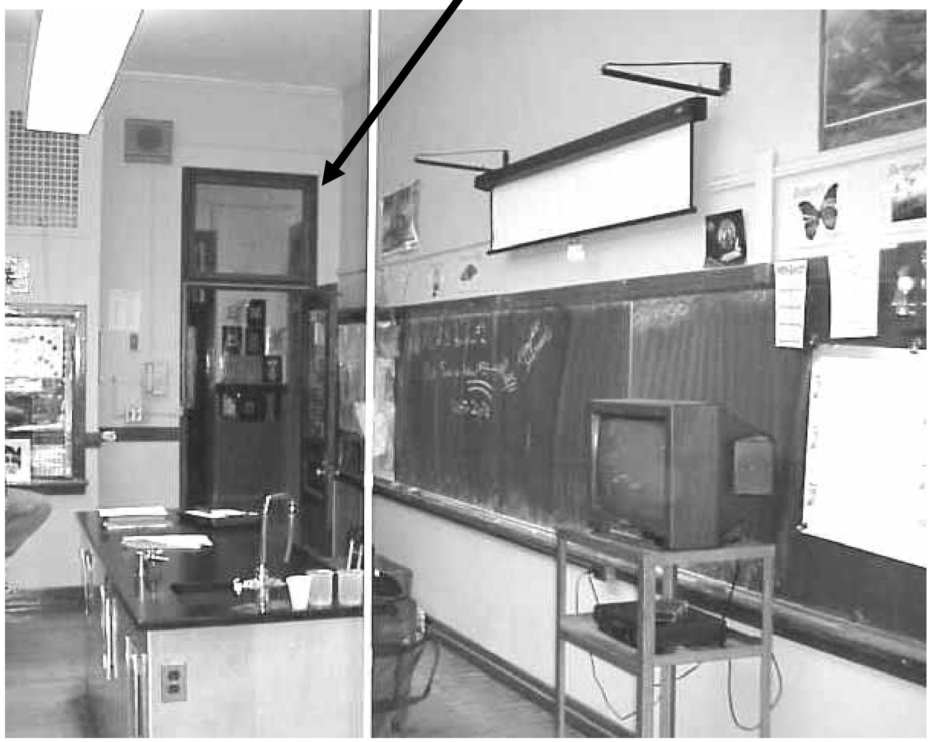
**Picture 6**



**Windows Used to Introduce Fresh Air in Heat Elements in the Basement Heating Vault**

**Picture 7**

**Transom**

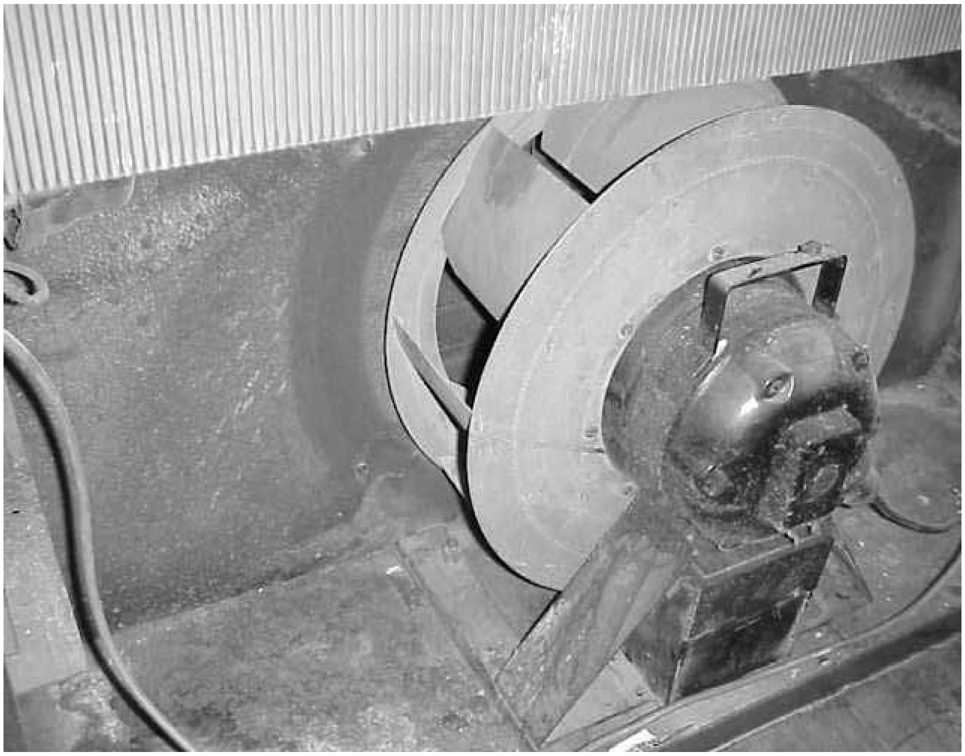


**Transom above Hallway Door in 1919 Wing**

**Picture 8**

**Univent in the 1897 wing with its Front Cover Removed**

**Picture 9**



**Fan Inside of Univent**

**Picture 10**

**Fresh Air Supply Vent Moveable Louvers behind Univent Fan**

**Picture 11**

**Openable Windows in the 1897 Wing**

**Picture 12**

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**Plants Impinging on 1919 Wing Exterior Wall**

**TABLE 1**

## Indoor Air Test Results – Forest Park Middle School, Springfield, MA – May 11, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Outside (Background) | 424 | 68 | 37 | | | | | |
| 211 | 1264 | 75 | 33 | 0 | yes | yes | yes | supply and exhaust off, door open, transom |
| 212 | 689 | 75 | 32 | 0 | yes | yes | yes | supply and exhaust off, window open, chalk dust, transom-closed |
| 212A | 758 | 75 | 33 | 0 | yes | yes | yes | supply and exhaust off, transom-closed |
| 213 | 742 | 75 | 34 | 2 | yes | yes | yes | supply and exhaust off, window open, transom-closed |
| 210 | 1155 | 75 | 35 | 0 | yes | yes | yes | supply and exhaust off, door open, transom-closed |
| 209C | 1166 | 77 | 36 | 10 | yes | no | no | window and door open, transom |
| 214 | 971 | 76 | 31 | 10 | yes | yes | yes | supply and exhaust off, window open, chalk dust, plants, transom, sink |
| 209 | 1023 | 77 | 34 | 0 | yes | yes | yes | supply and exhaust off, transom |
| 215 | 977 | 76 | 33 | 14 | yes | yes | yes | supply and exhaust off, transom, plants |
| 216 | 512 | 74 | 34 | 2 | yes | yes | yes | supply and exhaust off, transom-closed |

*** ppm = parts per million parts of air**
**CT = water-damaged ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 2**

## Indoor Air Test Results – Forest Park Middle School, Springfield, MA – May 11, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| 110 | 462 | 71 | 36 | 0 | yes | yes | yes | supply and exhaust off, window and door open, transom-closed |
| 107 | 811 | 73 | 36 | 12 | yes | yes | yes | supply and exhaust off, window and door open, transom-closed, chalk dust |
| 111 | 64 | 73 | 35 | 12 | yes | yes | yes | supply and exhaust off, transom-closed, chalk dust |
| 112 | 625 | 74 | 36 | 18 | yes | yes | yes | supply and exhaust off, window open, transom-closed, chalk dust |
| 106 | 647 | 74 | 35 | 27 | yes | yes | yes | supply and exhaust off-exhaust blocked by chair, window open, transom-closed |
| 105 | 672 | 75 | 38 | 22 | yes | yes | yes | supply and exhaust off, window and door open, transom-closed, chalk dust |
| Teacher's Lounge | 803 | 77 | 36 | 11 | yes | yes | yes | supply and exhaust off, door open, transom-closed, coke machine |
| Auditorium | 913 | 75 | 34 | 40+ | yes | yes | yes | supply and exhaust off, planter |
| Speech Room | 848 | 73 | 32 | 0 | yes | no | no | |
| 208 | 839 | 75 | 35 | 7 | yes | yes | yes | supply and exhaust off, window open, transom |

*** ppm = parts per million parts of air**
**CT = water-damaged ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 3**

## Indoor Air Test Results – Forest Park Middle School, Springfield, MA – May 11, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| 207 | 916 | 76 | 33 | 0 | yes | yes | yes | supply and exhaust off, transom-closed |
| Vice-Principal's Office | 618 | 75 | 36 | 1 | yes | no | no | window and door open, transom |
| 206 | 1190 | 76 | 39 | 1 | yes | no | no | transom-closed, door open |
| 205-Art Room | 1139 | 75 | 36 | 0 | yes | yes | yes | supply off, exhaust blocked by cabinet, window open |
| 204 | 1151 | 76 | 34 | 21 | yes | yes | yes | supply and exhaust off, window and door open |
| 203 | 1026 | 74 | 31 | 13 | yes | yes | yes | supply and exhaust off-back-draft from exhaust, window open |
| 202 | 853 | 74 | 37 | 17 | yes | yes | yes | supply and exhaust off, window and door open, chalk dust |
| Detail Office | 1108 | 76 | 35 | 1 | no | no | yes | passive exhaust, door open, floor fan |
| 224 | 1478 | 72 | 39 | 8 | yes | yes | yes | supply and exhaust off |
| 223 | 933 | 73 | 41 | 18 | yes | yes | yes | supply and exhaust off, window open, un-vented dryer |
| 103 | 861 | 75 | 37 | 2 | yes | yes | yes | supply off-blocked by book bags, window and door open |

*** ppm = parts per million parts of air**
**CT = water-damaged ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred<br>600 - 800 ppm = acceptable<br>> 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

TABLE 4

## Indoor Air Test Results – Forest Park Middle School, Springfield, MA – May 11, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| 104 | 676 | 75 | 39 | 0 | yes | yes | yes | supply off, window open, water damaged plaster |
| 114 | 825 | 73 | 35 | 13 | yes | yes | yes | supply off, exhaust blocked by file cabinet, window open |
| Cafeteria | 1622 | 74 | 45 | 300+ | yes | yes | yes | supply and exhaust off |
| 17 | 634 | 72 | 46 | 0 | yes | no | yes | window open |
| 18A | 1388 | 73 | 46 | 1 | yes | no | no | plants in window box |
| 18 | 915 | 72 | 43 | 25 | yes | no | yes | window and door open, plants |
| 19 | 848 | 73 | 40 | 1 | yes | no | yes | window open, plants, abandoned sink |
| 20 | 486 | 71 | 35 | 0 | yes | no | no | window open |
| 108 | 792 | 72 | 38 | 4 | yes | yes | yes | supply and exhaust off, window and door open, transom-closed, plants, rubber cement |
| 109 | 881 | 74 | 39 | 0 | yes | yes | yes | supply and exhaust off, window open, transom-closed |

*** ppm = parts per million parts of air**
**CT = water-damaged ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

TABLE 5

## Indoor Air Test Results – Forest Park Middle School, Springfield, MA – May 11, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| 109A | 977 | 75 | 35 | 12 | yes | yes | yes | supply and exhaust off, transom-closed |
| 222 | 1238 | 73 | 38 | 8 | yes | yes | yes | supply and exhaust off, modern windows |
| 221 | 1179 | 73 | 37 | 8 | yes | yes | yes | supply and exhaust off, door open |
| 122 | 1324 | 73 | 39 | 28 | yes | yes | yes | supply and exhaust off, modern windows, chalk dust |
| 121 | 1136 | 73 | 39 | 0 | yes | yes | yes | supply and exhaust off, modern windows, water damaged plaster |
| 120 | 1261 | 74 | 38 | 1 | yes | yes | yes | supply and exhaust off, modern windows, water damaged plaster, door open |
| 118 | 1308 | 75 | 37 | 14 | yes | yes | yes | supply and exhaust off, chalk dust, door open |
| 119 | 652 | 73 | 36 | 0 | yes | yes | yes | supply and exhaust off |
| 117 | 626 | 74 | 34 | 0 | yes | yes | yes | supply and exhaust off-exhaust blocked with paper, window and door open |
| 101 | 846 | 74 | 40 | 0 | yes | yes | yes | supply off, window open, water damaged plaster |

*** ppm = parts per million parts of air**
**CT = water-damaged ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 6**

## Indoor Air Test Results – Forest Park Middle School, Springfield, MA – May 11, 2000

| Remarks | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| 102 | 927 | 75 | 36 | 9 | yes | yes | yes | supply and exhaust off, chalk dust, planter |
| 116 | 654 | 74 | 36 | 12 | yes | yes | yes | supply and exhaust off-exzhaust blocked by file cabinet, chalk dust, window open |
| 115 | 1051 | 74 | 38 | 1 | yes | yes | yes | exhaust off-blocked by box, door open, chalk dust |

*** ppm = parts per million parts of air**
**CT = water-damaged ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |